Project ID: EEMS024

U.S. DEPARTMENT OF ENERGY

SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

MA3T-MobilityChoice: Analyzing the Competition, Synergy and Adoption of Fuel and Mobility Technologies

Zhenhong Lin, ORNL

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Argonne NATIONAL LABORATORY

INL Idaho National Laboratory

BERKELEY LAB

OAK RIDGE National Laboratory

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Overview

- Timeline
  - 10/2016-9/2019;
  - 50% completed
- Budget
  - $146k/year, planned
  - $146k received in FY17
- Barriers
  - Costs of advanced powertrains
  - Behavior of producer/consumer
  - Infrastructure
  - Incentives, regulations and other policies

- Partners/Collaborators
  - ORNL: Fei Xie, Shawn Ou
  - Industry: Denso, SRA
  - Academia: UT Austin
  - Gov/Lab: DOE, ANL, NREL, LBL, INL
- Resources
  - May need more collaboration for assumption support

Imagine "petroleum-based VMT x 2"

- DOE VTO mission
  - "supports research, development (R&D), and deployment of efficient and sustainable transportation technologies" to … " increase America's energy security, economic vitality, and quality of life"
- Induced travel demand from smart mobility can worsen energy & emissions, unless efficiency and clean fuels are promoted
  - CA SB 802, zero-emission requirement for self-driving cars removed just before committee votes on 4/18/2017. Is the requirement necessary or over-sensitive?
- Important to understand market dynamics btw fuel and mobility technologies

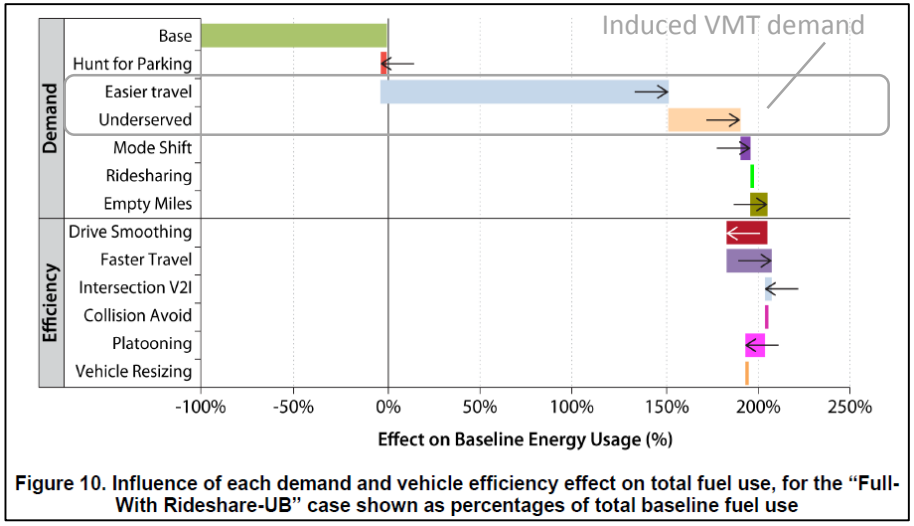
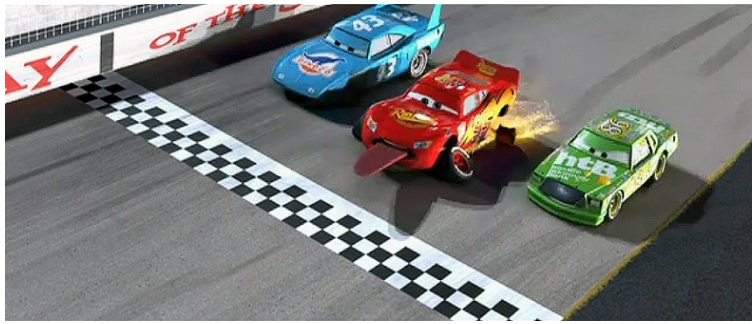


Figure 10. Influence of each demand and vehicle efficiency effect on total fuel use, for the "Full-With Rideshare-UB" case shown as percentages of total baseline fuel use

Source: T. Stephens, et. al. 2016. "Estimated Bounds and Important Factors for Fuel Use and Consumer Costs of Connected and Automated Vehicles". NREL/TP-5400-67216

Market penetration race:
"efficiency/clean fuel" vs "smart mobility"



Note: some acronyms explained in backup slides

MA3T-MC model framework is consistent with the EEMS future state narratives framework

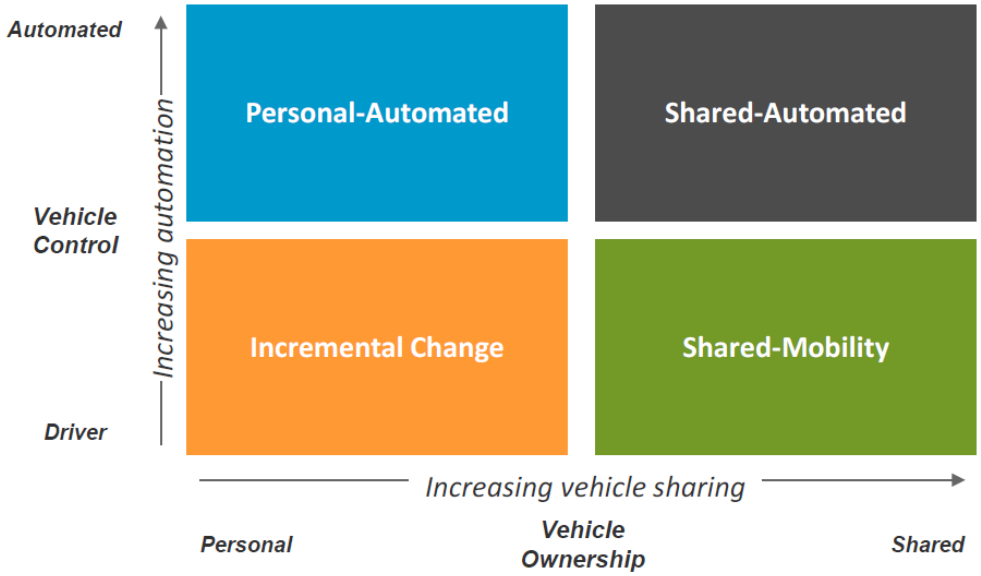
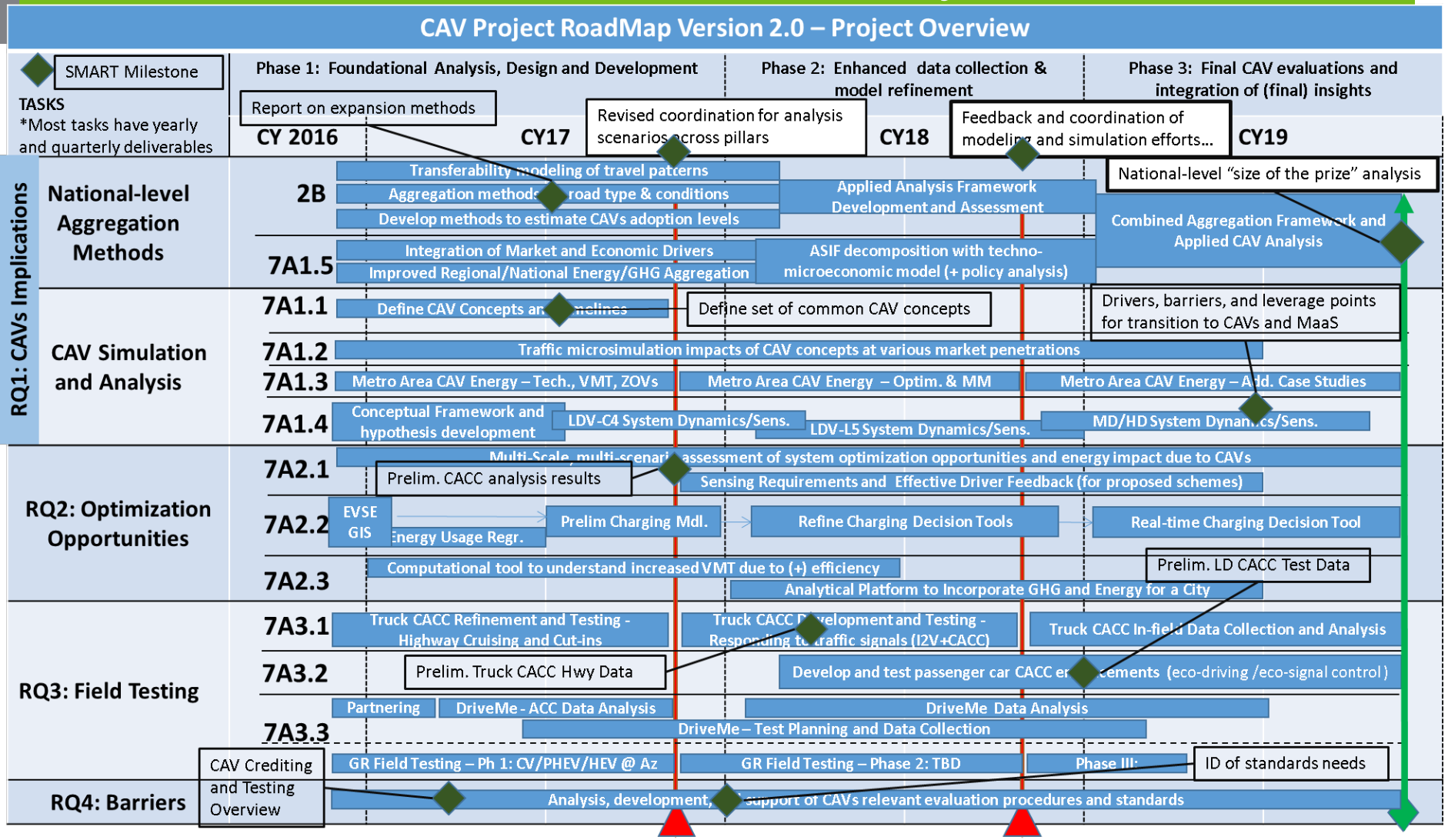


Figure 4. Future state narratives framework[6]

Source: U.S. DOE/EERE 2017. The Transforming Mobility Ecosystem: Enabling an Energy-Efficient Future

- MA3T-MC modeling goal—to analyze market dynamics/transition of fuel and mobility
- Competition and synergy between electrification, automation and sharing
- Consumer heterogeneity: who will choose what and why?
- R&D planning: what are the near-term bottlenecks and long-term priorities?
- Policy intervention: when and where needed, and how?

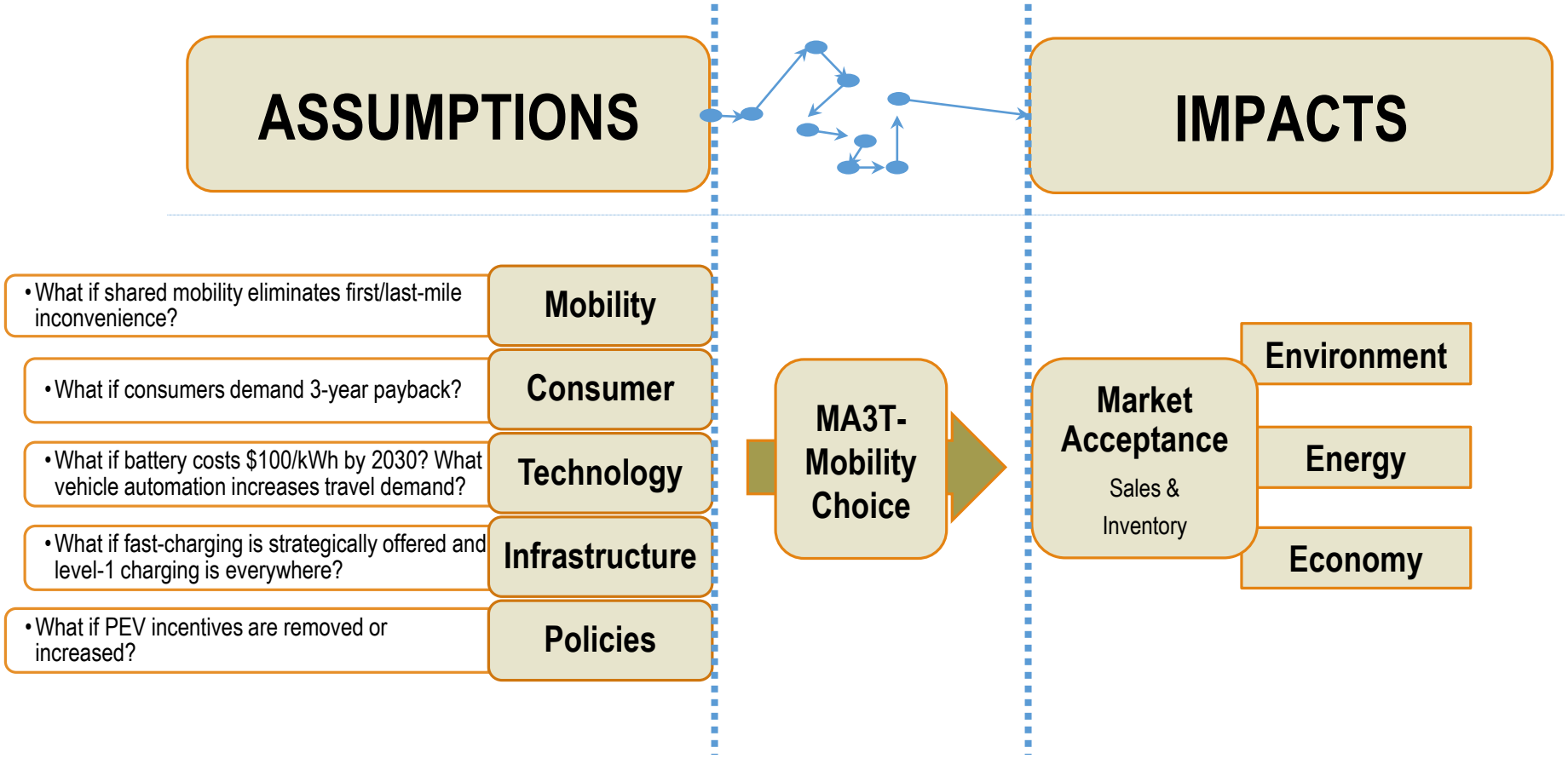
MA3T-MC supports and depends on other SMART Mobility tasks



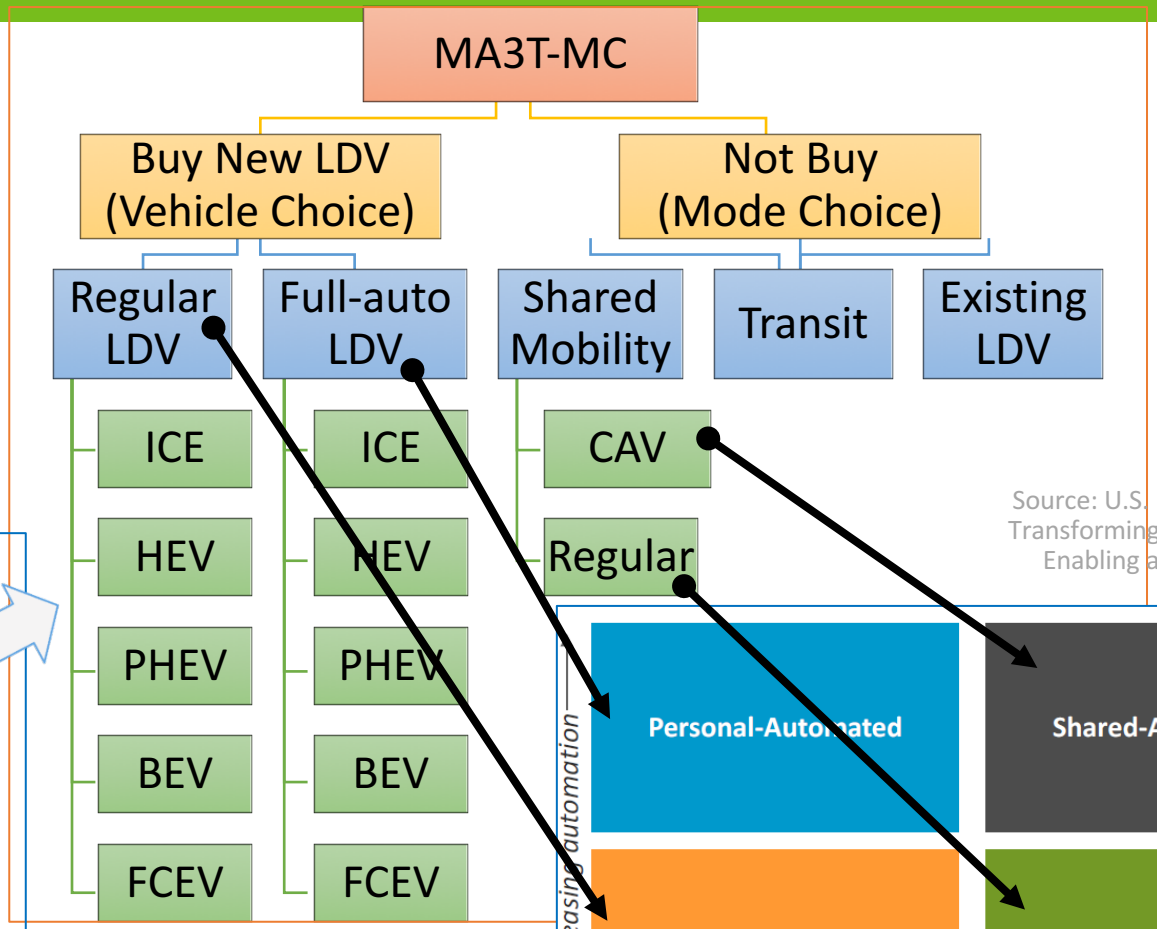
On track to meet all milestones

Milestone Description	Month/Year	Status
Preliminary analysis results of MA3T-MC	03/31/2017	Complete
Update ANL-NREL-ORNL CAV energy impact study with adoption-based analysis	09/30/2017	On schedule

Quantify assumption-impact linkages with systems dynamics models

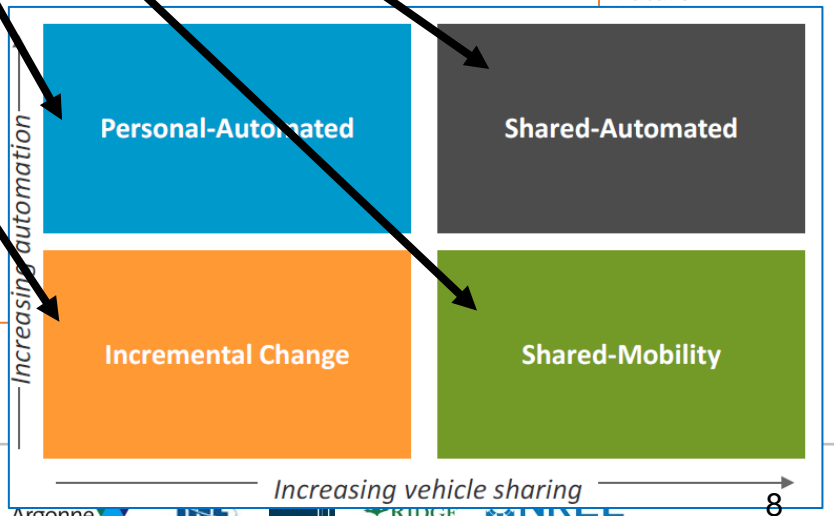


MA3T-MC choice structure echoes with EEMS future state narratives framework and covers almost all DOE VTO R&D activities



DOE R&D portfolio
- advanced batteries and electric drive systems
- lightweight materials
- advanced combustion engines
- alternative fuels
- energy efficient mobility systems

Source: U.S. DOE/EERE 2017. The Transforming Mobility Ecosystem: Enabling an Energy-Efficient Future



Consumer surveys, stakeholder engagement and existing models

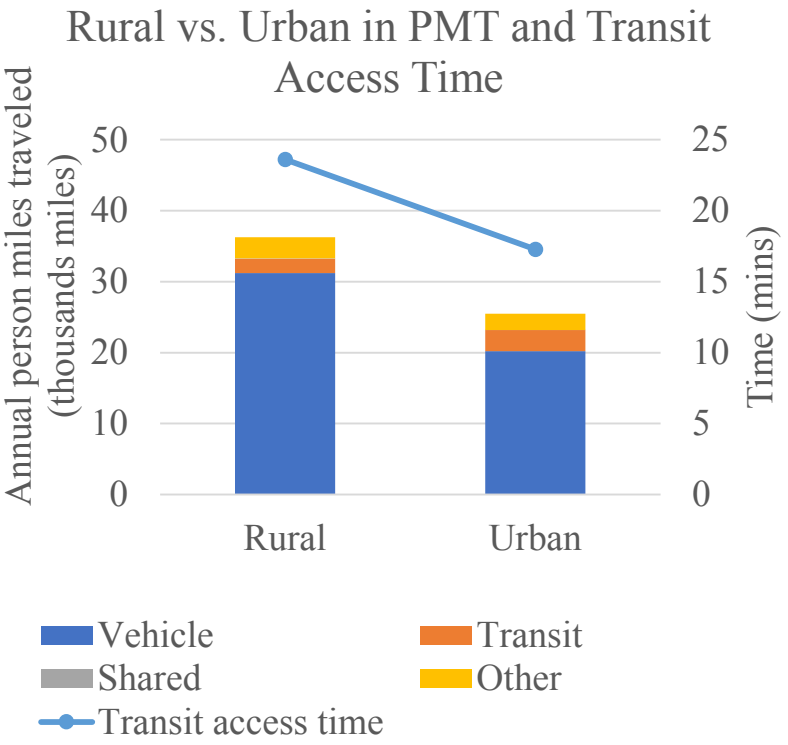
- Consumer surveys
  - Advanced PEV Travel and Charging Behavior survey
  - Beijing Household Travel Survey
  - National Household Travel Survey
  - Seattle GPS travel data
  - Northern California Multi-tasking Travel Survey
  - Mobility services cost-benefit calculator (potentially used for survey)
  - WholeTraveler survey
- Industry stakeholder interests
  - "Insurance" value of vehicle features
  - Consumer valuation of efficiency
  - Automation and electrification
- Existing models and capabilities
  - TEDB, Autonomie, GREET, VISION, SERA, the EV Project, Polaris

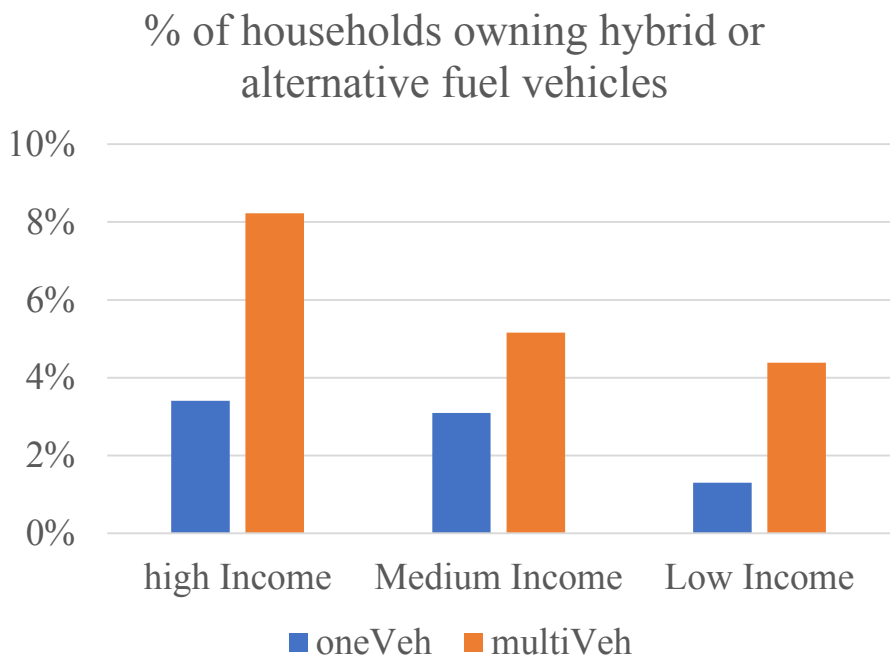
Characterization of heterogenous consumers

- 1080 consumer segments
  - Area type: rural, urban
  - Income Level: High, low, median
  - Number of household vehicles: 0 or 1 vehicle, multiple vehicles
  - Home charging availability
  - Lifestyle: young children, retired, other
  - Driving intensity: average, frequent, modest
  - Risk: Innovator, early adopter, early majority, late majority, laggard
- Consumer attributes
  - Household annual PMT, VPMT, VMT, shared PMT, trip number, per-trip time, vehicle occupancy, transit access time, transit wait time, commute distance

Heterogenous consumers described by correlated and mobility-relevant attributes

- Urban households--lower total PMT, higher transit PMT, and shorter transit access time
- High income and multi-vehicle households – high HEV/AFV ownership

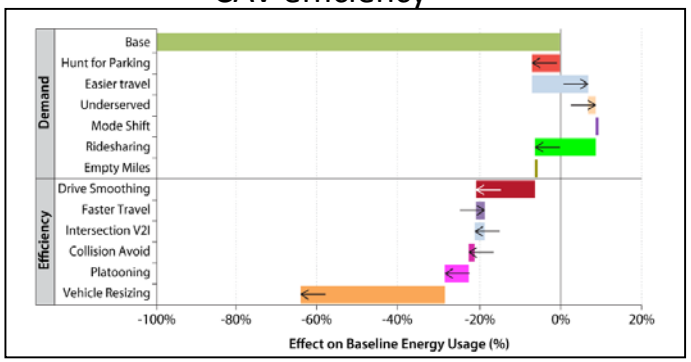




Automated vehicles likely more expensive and more efficient

- Key assumption (for model testing purpose only) on fully-automated vehicles
  - 2030: cost x 1.5, fuel rate x 1
  - 2050: cost x 1, fuel rate x 0.5

CAV efficiency



CAV incremental cost

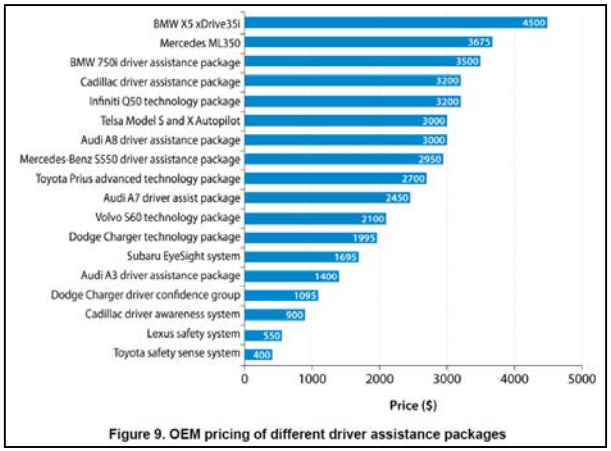
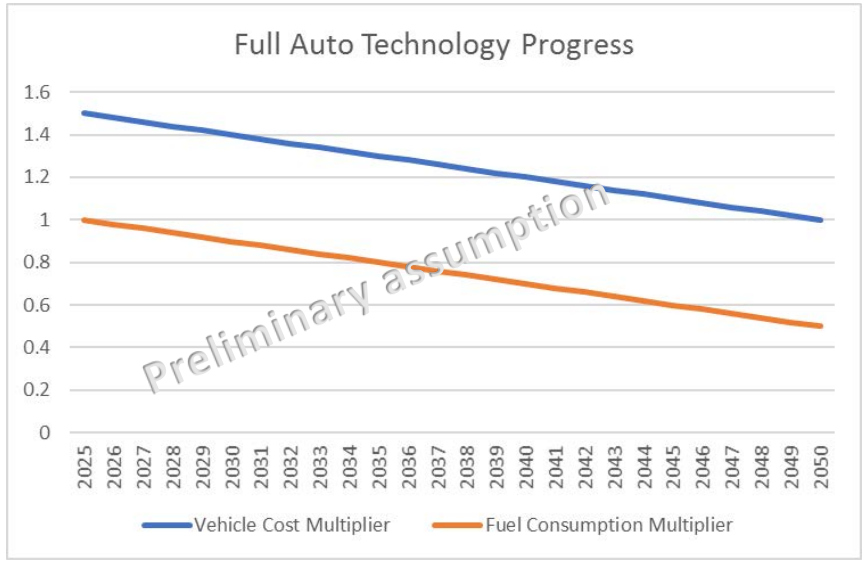


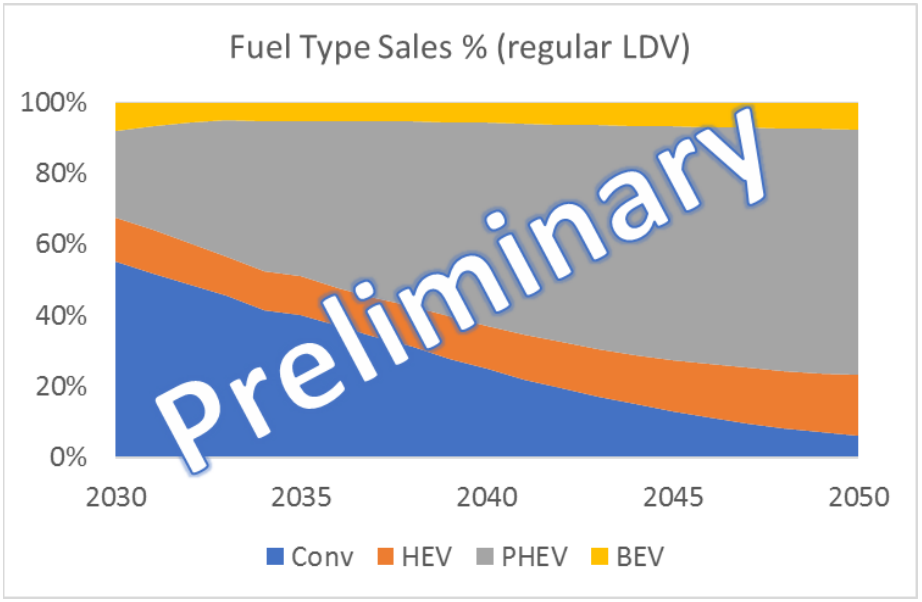
Figure 9. OEM pricing of different driver assistance packages

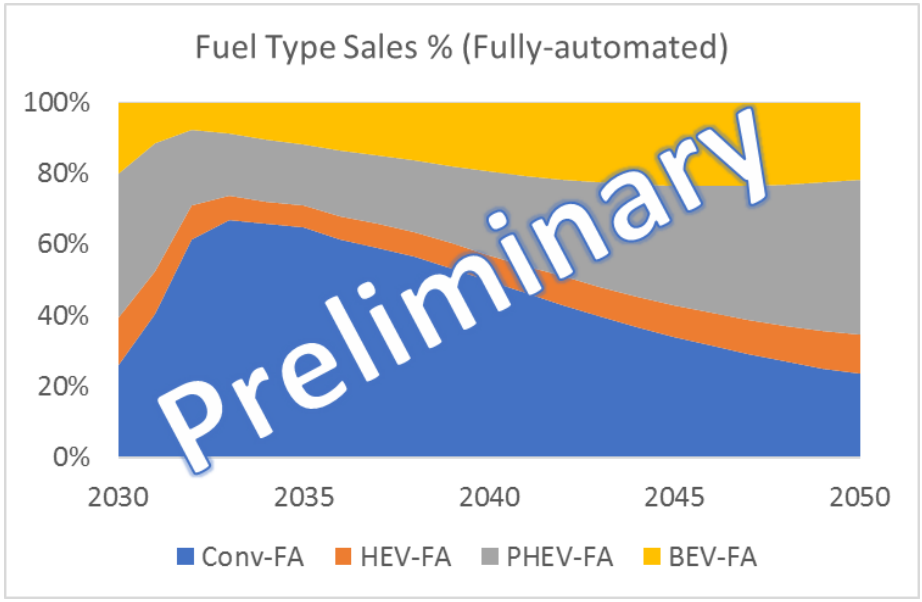


Source: T. Stephens, et. al. 2016. "Estimated Bounds and Important Factors for Fuel Use and Consumer Costs of Connected and Automated Vehicles". NREL/TP-5400-67216

MA3T-MC: synergy between vehicle automation and electrification

- Preliminary observation: range-limited BEVs benefit more from automation than efficient technologies (PHEVs and HEVs)
  - Same efficiency gain (assumption) leads to larger energy cost savings for conventional ICE vehicles than for already-efficient PHEV and HEV
  - But for range-limited BEVs, the automation-enabled efficiency gain leads to valuable range extension





Responses to Previous Year Reviewers' Comments

- Not reviewed last year

Collaboration and Coordination

Topic	Collaborator Institution
Energy impact of CAVs	ANL, NREL, UTK
MA3T-MC calibration	SRA, ANL
Charging behavior	Iowa S. U., INL, LBL
Consumer attitude linkage	George Tech, KAPSARC
Consumer mobility cost-benefit	UT Austin, ANL, NREL
PEV Household travel behavior	UC Davis, LBL
CAV efficiency	ANL, NREL

Remaining Challenges/Barriers

- CAV date on market (exogenous assumption)
- CAV incremental cost
- Stress and safety benefit of CAV and shared mobility
- Feedback loop collaboration with other CAV and SMART Mobility tasks

Proposed Future Research

- Refine key assumptions by collaborating with other SM task teams
  - Travel time value, stress reduction and safety benefit
  - Consumer utility of shared mobility
  - Automated vehicle cost
  - Demographic shifts due to urbanization and aging
- MA3T-MC model calibration
  - What can we learn from past experiences on car/ride sharing?
- Quantifying the 4 EEMS future narratives of mobility
  - Incremental-Change, Personal-Automated, Shared-Mobility, and Shared-Automated
  - Focus on market shares, dynamics (competition and synergy), technology R&D priorities, policy opportunities and energy impact

Summary

- MA3T-MC is developed to support scenario analysis of EEMS future narratives framework
- Consumer heterogeneity with correlation is characterized
- MA3T-MC is functional, showing logical results, but needs continued improvements
- Preliminary results show that under certain circumstances, automation can accelerate BEV acceptance and slow down PHEV/HEV
- Future improvements of MA3T-MC will benefit from on-going SMART Mobility tasks

ACKOWLEDGEMENTS

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Contact:

Zhenhong Lin
Principle Investigator
National Transportation Research Center
Oak Ridge National Laboratory
(865) 946-1308
linz@ornl.gov

Technical Backup Slides

Selected acronyms explained

BEV	Battery electric vehicle
CAV	Connected and automated vehicles
FCEV	Fuel cell electric vehicle
HEV	Hybrid electric vehicle
ICE	Internal combustion engine
MA3T	Market Acceptance of Advanced Automotive Technologies
MA3T-MC	MA3T-MobilityChoice
PHEV	Plug-in hybrid electric vehicle
PMT	Passenger miles traveled
SM	SMART Mobility
TEEM	Transportation Energy Evolution Modeling

QUESTIONS?